Switchable cam follower or switchable support element of a valve train of an internal combustion engine

Field of the invention

The invention concerns a switchable cam follower or a switchable support element of a valve train of an internal combustion engine, said cam follower or support element comprising an outer part which is assembled together with an inner part that is displaceable relative thereto in a direction of cam lift, said inner part comprising, at a parting gap to the outer part, two spaced apart or opposing openings for coupling means, each of said openings being aligned, at one cam position, to a further opening for coupling means in the outer part, the coupling means being configured and arranged so that, in a coupled state, each coupling means extends beyond the parting gap on one coupling side while simultaneously extending in the opening of the outer and the inner part.

Background of the invention

A cam follower of the pre-cited type configured as a bucket tappet is known from DE 198 01 701 A1. A drawback of this cam follower is that both its coupling sides have to be manufactured extremely exactly with respect to the idle stroke of the two coupling means and with respect to the radial clearance and a tolerance of the radial clearance. Likewise, only the smallest possible shape deviations are allowed. Thus, a switchable cam follower in keeping with the above requirements has a relatively complex structure and therefore also causes high manufacturing costs. At the same time, the system-related risk at the two coupling sides increases due to the double precision required.

Objects of the invention

The object of the invention is to provide a cam follower or a support element of the pre-cited type that eliminates the mentioned drawbacks.

Summary of the invention

The invention achieves the above object by the fact that in an uncoupled position of the coupling means, an axial idle stroke of the coupling means on the one coupling side till coupling is achieved is large and the axial idle stroke of the coupling means on the further coupling side till coupling is achieved is small.

Alternatively to or in conjunction with the above measures, a further subject matter of the invention is that, in a coupled state of the coupling means, a radial clearance of the coupling means, alone or together with a tolerance of the radial clearance relative to its opening, is large on the one coupling side and small on the further coupling side.

Thus, the increased manufacturing work discussed above is required only on the one coupling side while the further coupling side does not need such fine finishing with regard to the axial idle stroke and the radial clearance. Manufacturing work and costs can therefore be drastically reduced without an appreciable effect on the properties of the cam follower or the support element.

The coupling of the invention according to the first solution is designed so that the coupling means on the further, finely toleranced coupling side is always the first to extend in the corresponding opening. The hitherto possible adverse effect of a faulty switching, for example if the coupling means is not sufficiently extended despite an imparted coupling command, with the result that the coupling means slips out and the load-bearing component is strongly overloaded, is no longer possible. It is thus the coupling means on the further coupling side that positively

bears the load at first when the coupling command is imparted, and only then the coupling means on the one coupling side.

According to a further proposition of the invention, in the case of rotationally symmetric cam followers such as bucket tappets, roller tappets or rotationally symmetric support elements, at least one edge of the opening on the one, coarsely toleranced coupling side, is left simply cylindric. The edge for the coupling means on the other, finely toleranced coupling side can be flattened as proposed by the invention, but this is not compulsory. In this way, again, manufacturing costs for fabricating a flat surface at least on the one coupling side are saved. On the further coupling side with the flat surface and a sufficiently long traveling path of the respective coupling means beyond the edge of the fore-positioned opening, the coupling means is immediately surrounded all round and thus has excellent load-bearing properties.

A further contribution to minimizing the manufacturing costs is obtained if, as mentioned above, the radial clearance, for example, together with a tolerance of the radial clearance of the coupling means, is large on the one coupling side and small on the further coupling side. The clearance is considered here as the idle travel path of the coupling means within its opening (cam lift direction). However, as soon as the small radial clearance on the "fine" coupling side has been overcome, a desired lift transmission takes place. Thus, the radial clearance on the coarsely toleranced coupling side is not determinative. This only brings about a slightly increased tilting of the outer part relative to the inner part which can be accepted.

The scope of the invention extends particularly to switchable cam followers like the aforesaid bucket tappets but also to roller and mushroom tappets for activating tappet push rods, to lever-type cam followers, to switching bridge members for activating a plurality of identically operating gas exchange valves and to switchable support elements, in so far as a two-sided coupling mechanism is used.

The scope of the invention further extends to switchable valve train elements in which it is not an assembly of slides that is moved in one single direction but in which two similar coupling means are provided, for example in the inner part, and are displaced radially outwards beyond the parting gap for achieving coupling.

According to a further advantageous feature of the invention, the openings are made as bores and the coupling means as piston-like slides. However, it is also conceivable to configure the openings differently, for example with multiple edges, so that many different types of coupling means will occur to a person skilled in the art to replace the slides, for instance wedges, balls or the like.

According to another feature of the invention, separate sleeves are provided which eliminate the need for a complex fine finishing of the slide ways for the coupling means on the cam follower,

According to still another feature of the invention, the outer part is annular in shape and the inner part is arranged in the bore of the outer part. It is, however, clear that the scope of the invention is not limited only to rotationally symmetric cam followers and support elements. Thus, for example, cam follower components, such as levers, arranged next to each other are also covered by the invention.

A preferred cam position for the displacement of the coupling means is a base circle contact of the associated cam or cams, but other positions of lift are also conceivable in this connection.

The openings for the coupling means in the outer part are preferably situated diametrically opposite each other. However, the invention also covers an offset positioning of the openings in peripheral or vertical direction. It is also conceivable not to make the opening in the inner part as a through-bore but to provide pocket bores.

Finally, it is also in keeping with the invention to omit the flattening of the one edge if the corresponding coupling means is secured against rotation in its opening and its front end in coupling direction has a geometry that is complementary to the opposing surface.

Brief description of the drawing

The invention will now be described more closely with reference to the appended drawing.

Fig. 1 is a longitudinal section through a bottom region of a switchable cam follower of the invention configured as a bucket tappet, and

Fig. 2 is a section along line II-II of Fig. 1.

Detailed description of the drawing

The structure:

As disclosed in the two figures, the cam follower 1 comprises a cylindrical outer part 2 in whose bore 3 an inner part 4 is arranged for relative axial displacement thereto. An annular parting gap 5 extends between the inner and the outer part 4, 2. The inner part 4 has two diametrically opposite openings 6, 7 that merge together to form a through-bore. Both openings 6, 7 have an edge 8, 9. Aligned to each edge 8, 9 in one cam position (here base circle contact run) is situated an opposing further opening 10, 11 for coupling means to be described later. In the uncoupled state, the opening 10 on one coupling side 12 does not comprise any coupling means, whereas, in the opening 11 on a further coupling side 13 is positioned a coupling means 14 configured as a piston-like slide.

A coupling means 15 configured as a piston-like slide is arranged in the inner part 4. It can be seen that the coupling means 15 bears through one of its end faces 16

directly against a crowned front end 17 of the other coupling means 14 in the uncoupled state shown in the figures (cam base circle contact run). In the region of the one coupling side 12, in contrast, a further end face 18 of the coupling means 15 is configured so as to be spaced from the parting gap 5.

A person skilled in the art will further see in the figures that in the openings 6, 7 of the inner element 4 that merge to form a through-bore is mounted a sleeve-like body 19, and the coupling means 15 extends directly in the bore 20 of this sleeve-like body 19. Similarly, the opening 11 on the further coupling side 13 also comprises a sleeve-like body 21 for the coupling means 14 which extends directly in the bore 22 of this sleeve-like body 21. Upon a sufficient coupling movement of the coupling means 14 into the opening 7, the edge 9 on the sleeve-like body 19 surrounds the coupling means 14 annularly, that is to say, all round. On the opposite one coupling side 12, in contrast, this advantage does not exist but, as elucidated below, this can be accepted without any problem.

The function:

It can be seen from both figures that in the shown uncoupled position of the coupling means 14, 15 that are positioned aligned behind each other in the form of a slide assembly, an idle stroke of the coupling means 15 on the one coupling side 12 into the opening 10 till coupling is achieved is clearly larger than the idle stroke of the coupling means 14 on the further coupling side 13 till it is reliably displaced past the edge 9 and the parting gap 5 into the opening 7 of the inner element 4. Thus load is supported in any case at first on the further coupling side 13 before a reliable coupling is realized on the one coupling side 12. In other words, the distances covered by the coupling means 14, 15 for coupling are dimensioned so that it is always the coupling means 14 on the further coupling side 13, which is finely toleranced with regard to the axial idle stroke, that is the first to support load. The one coupling side 12 that is clearly more coarsely toleranced couples only later. It is never possible for the "coarse" one coupling side 12, that is cylindrically curved at the edge of the opening 10, to be the first to support load. Because, in

this way, the precise, further coupling side 13 that is displaced into the optionally flat edge 9 of the opening 7 is coupled at first, it is no longer possible for the coupling means 15 to slip out of the merely cylindrical edge of the opening 10 that has only low load-bearing properties.

In this way, an increased component loading at discrete points of the coupling means 14, 15 is avoided without recourse to special measures. Due to the fact that only the further coupling side 13 is exactly configured with regard to the axial idle stroke, costs of manufacturing as well as the system-related risk in the coupling mechanism are drastically reduced. In addition, the complexity of the structure is also reduced.

Further, a radial clearance and a tolerance of the radial clearance of the coupling means 14 on the further coupling side 13 can be precisely dimensioned, whereas a radial clearance and a tolerance of the radial clearance of the coupling means 15 on the one coupling side 12 is coarsely dimensioned. If desired, even the shape deviation can be toleranced as described above. The coarser dimensioning of the radial clearance on the one coupling side 12 results only in a slightly increased tilting of the outer part 2 relative to the inner part 4 in the coupled state. The radial play is determined by the further, finely toleranced coupling side 13. In this way, a transmission of lift takes place immediately after the coupling means 14 on the finely toleranced coupling side 13 has completed its very minimal idle stroke in cam-distal direction within the opening 7 of the inner element 4.

List of reference numerals

1	Cam follower
2	Outer part
3	Bore
4	Inner part
5	Parting gap
6	Opening
7	Opening
8	Edge
9	Edge
10	Opening
11	Opening
12	Coupling side
13	Coupling side
14	Coupling means
15	Coupling means
16	End face
17	Front end
18	End face
19	Body
20	Bore
21	Body
22	Bore